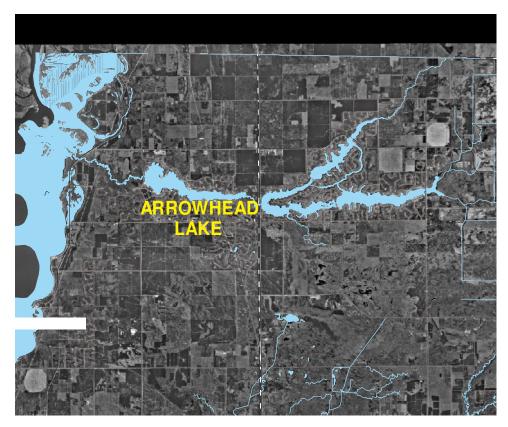


Presented by Reesa Evans, Lake Specialist Adams County Land & Water Conservation Department P.O. Box 287, Friendship, WI 53934

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Introduction

Information about Arrowhead Lake: Arrowhead Lake is located in the Town of Rome, Adams County, Wisconsin. The impoundment is 30 surface acres in size. Its maximum depth is 25.2', with an average depth of 8'. The dam impounds Fourteen-Mile Creek downstream from the dams at Lower and Upper Camelot Lakes and Sherwood Lake, on its way to the Wisconsin River. The dams on these lakes are owned and operated by Adams County. There is a public boat ramp located on southwest side of the lake owned by The Adams County Parks Department, as well as a public swimming beach. Heavy residential development around the lake is found along most of the lakeshore.





RE:2/07



While the surface watershed of Arrowhead Lake itself is not especially large, the lake receives the input of a very large surface watershed that extends eastward into the next county, with a large stream system that feeds into the Camelot and Sherwood Lakes, then into Arrowhead. Studies have shown that lakes are the products of their watersheds. Land use in the watersheds can impact on the water quality of a lake, especially in the amount and content of stormwater runoff from the surface. Natural undisturbed landscapes tend to have low runoff levels.

Land use categories in acreage and percent of total are shown on the chart below:

	Surface		Ground		Total	
Arrowhead Lake	Acres	% Total	Acres	% Total	Acres	% Total
AgricultureNon Irrigated	0	0.00%	87.84	1.83%	87.84	0.97%
AgricultureIrrigated	0	0.00%	0	0.00%	0	0.00%
Government	219.7	5.11%	21.6	0.45%	241.3	2.65%
Grassland/Pasture	158.24	3.68%	154.08	3.21%	312.32	3.43%
Recreational	501.38	11.66%	0	0.00%	501.38	5.51%
Residential	1714.85	39.90%	484.8	10.10%	2199.65	24.17%
Water	422.26	9.82%	0	0.00%	422.26	4.64%
Woodland	1282.58	29.83%	4051.68	84.41%	5334.26	58.63%
total	4299.01	100.00%	4800	100.00%	9099.01	100.00%

Residential land use is the largest category in the Arrowhead surface watershed and the second largest land use in the ground watershed. Woodlands are the largest land use category in the Arrowhead Lake ground watershed and second largest land use in the ground watershed. Since forest floors are often full of leaves, needles and other duff, runoff from forested lands may be more filtered than that from agricultural or residential lands. Residential lands, however, may contribute nutrients to the water from stormwater runoff, mowed lawns and impervious surface. Agriculture may also contribute significantly to the amount of nutrients in a watershed.

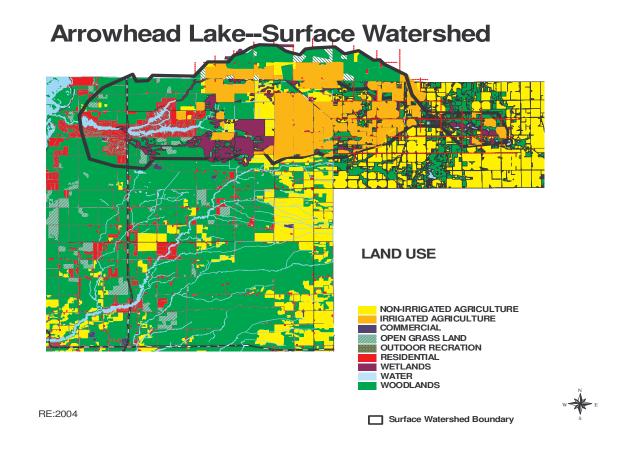
Like many lakes in Wisconsin, Arrowhead Lake is a phosphorus-limited lake. This means that of the pollutants that end up in the lake, the one that in the shortest supply and most affects the overall quality of the lake water is phosphorus. Land use types play a major role in determining the amount of phosphorus being loaded into the lake.

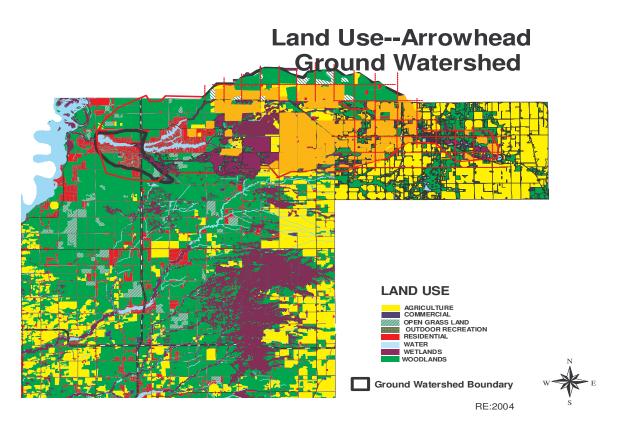
Some aspects of phosphorus loading can't be modified by human behavior—they are simply part of the natural landscape. However, phosphorus loading from agriculture, residential, recreational and septic use of the land can be decreased or increased. A series of studies done by various agencies in 2000-2002 indicated that phosphorus loading is coming not only from the upper watershed, but also from the lake shores and lake septic systems. Recent computer modeling, based on water quality tests taken between 2004-2006, suggest that shoreland residential stormwater runoff and septics may contribute more than 35% of the external phosphorus ending up in Arrowhead Lake per year.

Simply reducing the phosphorus input by 10% from residential land use (both types), recreational use, and septics would result in 72.82 pounds less per year of phosphorus. Perhaps this doesn't sound like much...unless you remember that one pound of phosphorus can produce up to 500 pounds of algae per year. Reducing the phosphorus load by 10% could result in 36,410 pounds **LESS** of algae per year! A 25% decrease could result in 109,025 fewer pounds of algae per year!







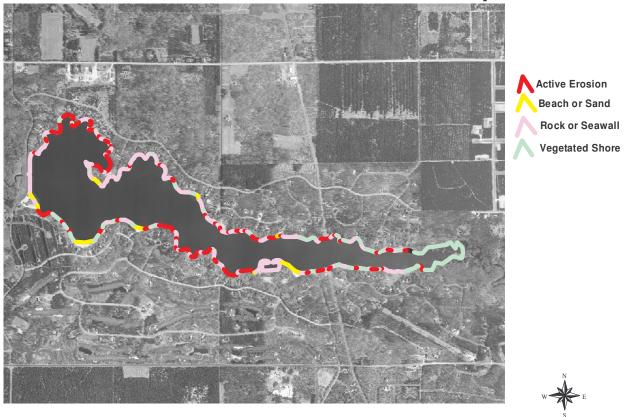


Shorelands



Arrowhead Lake has a total shoreline of 6.9 miles (36,432 feet). Almost all of the shore is in residential use. Much of it is steeply sloping. Slightly under 50% of the shore has native vegetation. 6.4% of the shore has significant active erosion. The remaining shore is a combination of natural rock, sand beaches, rock riprap, hard structures (piers, etc.) and cultivated lawn. Shoreland status in 2004 is shown on the map below.

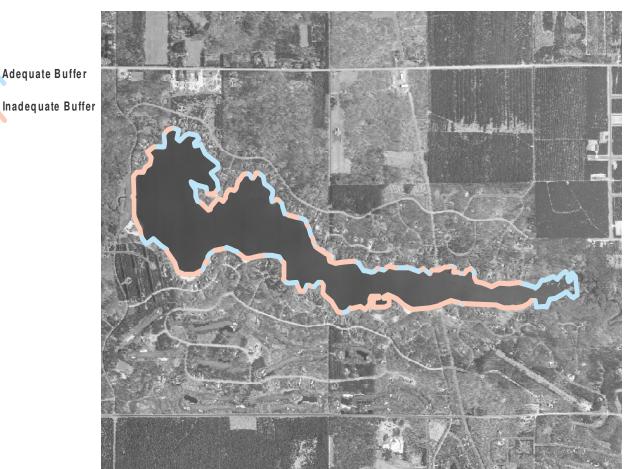
Arrowhead Lake Shoreland Map



RE/2004

A 2004 shore survey showed that less than 50% of the shore had an "adequate buffer." An "adequate buffer" is a native vegetation strip at least 35 feet landward from the shore. Most of the "inadequate" buffer areas were those with mowed lawns and/or insufficient native vegetation at the shoreline to cover 35 feet landward from the water line. Additionally, where there was rock or seawall, several lawns were mowed to the edge of the rock or seawall.

Buffers on Lake Arrowhead



RE:2004

Shoreland buffers are an important part of lake protection and restoration. These buffers are simply a wide border of native plants, grasses, shrubs and trees that filter and trap soil & similar sediments, fertilizer, grass clippings, stormwater runoff and other potential pollutants, keeping them out of the lake. A 1990 study by the Department of Natural Wisconsin Resources of Wisconsin shorelines a buffer of native revealed that vegetation traps 5 to 18 times more volume of potential pollutants than does a developed, traditional lawn or hardarmored shore. The filtering process and bank stabilization that buffers provide help improve or maintain a lake's water quality, including water clarity.



Example of Adequate Buffer



Example of Inadequate Buffer

Vegetated shoreland buffers help stabilize shoreline banks, thus reducing bank erosion. The plant roots give structure to the bank and also increase water infiltration and decrease runoff. A vegetated shore is especially important when shores are steep and sandy, as are many of the Arrowhead Lake shores.



One of the measures Wisconsin uses to give a general estimate of a lake's water quality is the **trophic state index**. This index looks at a lake's water clarity, its amount of total phosphorus (the element most related to aquatic plant and algal growth), and its chlorophyll-a level (chlorophyll-a is a pigment used by algae for photosynthesis).

Depending on the trophic index score, lakes are then classified as **Oligotrophic** (good), **Mesotrophic** (fair), or **Eutrophic** (poor):

- Good: Oligotrophic lakes have clear, deep water with few algal blooms. Larger game fish are often found in such lakes.
- Fair: Mesotrophic lakes have more aquatic plant and algae production, with occasional algal blooms and a good fishery. The water is usually not as clear as that of oligotrophic lakes.
- **Poor:** Eutrophic lakes are very productive, with lots of aquatic plants and algae. Algal blooms are often frequent in these lakes. They may have a diverse fishery, but rough fish (such as carp) are also common. Water is often cloudy or murky. Small shallow lakes are more likely to be eutrophic.

	Score	TSI Level Description
	30-40	Oligotrophic: clear, deep water; possible oxygen depletion in lower depths; few aquatic plants or algal blooms; low in nutrients; large game fish usual fishery
Arrowhead _	40-50	Mesotrophic: moderately clear water; mixed fishery, esp. panfish; moderate aquatic plant growth and occasional algal blooms; may have low oxygen levels near bottom in summer
Lake's overall TSI is 50	50-60	Mildly Eutrophic: decreased water clarity; anoxic near bottom; may have heavy algal bloom and plant growth; high in nutrients; shallow eutrophic lakes may have winterkill of fish; rough fish common
	60-70	Eutrophic: dominated by blue-green algae; algae scums common; prolific aquatic plant growth; high nutrient levels; rough fish common; susceptible to oxygen depletion and winter fishkill
	70-80	<u>Hypereutrophic:</u> heavy algal blooms through most of summer; dense aquatic plant growth; poor water clarity; high nutrient levels



Water clarity readings are usually taken by using a Secchi disk (shown at right). Average summer Secchi disk clarity in Arrowhead Lake in 2004-2006 was 5.99 feet. This is slightly more than the average for 1986-1992, when the Secchi disk average was 5.83'. Both these readings put Arrowhead Lake in the "fair" category of water clarity. These figures suggest that Arrowhead Lake's water clarity has stayed fairly steady for the last twenty years, i.e., it didn't decrease and it didn't substantially increase. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity often gets worse during the growing season due to increase in algae & other pollutants in the water, then clears up again by fall turnover.

Increased phosphorus levels in a lake will feed algal blooms and also may cause excess plant growth. It is recommended that for impoundments to avoid frequent algal blooms, phosphorus should be below 30 micrograms/liter. The 2004-2006 summer average phosphorus concentration in Arrowhead Lake was 18.62 micrograms/liter, below that amount. This puts Arrowhead Lake in the "good" category for growing season total phosphorus levels. 18.62 micrograms/liter is below the 21.87 micrograms/liter average for the 1990s and the 38.89 micrograms/liter average for the 1980s. Phosphorus levels have declined slightly since the 1990s and substantially since the 1980s. Frequent algal blooms would not be expected with the current readings.





The third measure used in trophic state classification is the amount of chlorophyll-a contained in the lake. The amount of chlorophyll-a found in a lake is an indication about the amount of algae in the lake. The 2004-2006 summer average chlorophyll-a concentration in Arrowhead Lake was 9.55 micrograms/liter. This level of chlorophyll-a gives Arrowhead Lake a "good" ranking for chlorophyll-a (i.e., it's lower than that of many impoundments in Wisconsin). The average for the 1980s was 9.27 micrograms/liter; the average for the 1990s was 14.65 micrograms/liter. All of these levels are low for impoundments in Wisconsin, suggesting that Arrowhead Lake has fewer algal blooms than most impoundments in Wisconsin.

In-Lake Habitat

Aquatic Plants

A diverse aquatic plant community plays a vital role in improving water quality, providing valuable habitat resources for fish and wildlife, resisting invasions of non-native species and checking excessive growth of the most tolerant species.

An updated aquatic plant survey was performed in 2006. The 1.5'-5' depth zone supported the most abundant aquatic plant The Arrowhead Lake aquatic plant growth. community is characterized by average quality and average species diversity for impoundments. Most of the species present are those that tolerate "Disturbance" includes physical disturbance. disturbances to plant beds such as boat traffic, plant harvesting, chemical treatments, dock and other structure placements, shoreline development & fluctuating water levels. **Biological** disturbances such as an introduction of invasive species can also promote growth of disturbancetolerant plants.

Chara spp (muskgrass), Najas flexilis (bushy pondweed), Potamogeton pectinatus (sago pondweed) and Potamogeton zosteriformis (flatstemmed pondweed) were the most common aquatic species.

Important to maintaining a diverse aquatic plant community is an integrated aquatic plant management plant that controls the invasive plants in the lake. The invasive exotics currently *Myriophyllum spicatum* (Eurasian watermilfoil) and *Potamogeton crispus* (curly-leaf pondweed) had similar occurrence frequencies, although the EWM was somewhat more dense than the CLP. One invasive plant, *Phalarais arundinacea* (reed canarygrass) was found, but only in a couple of places and in low density.



Curly-Leaf Pondweed



Reed Canarygrass



Eurasian Watermilfoil

Some of the emergents found on Arrowhead Lake: (top to bottom) *Eleocharis acicularis* (needle spikerush); *Sagitarria latifolia* (arrowhead); *Scirpus validus* (soft-stem bulrush).







An aquatic plant survey had been performed in 2000 on Arrowhead Lake. Both surveys revealed that many of the aquatic plants in the lake occur at higher than desired densities. In both surveys, rooted plants were found at a deeper level than would be expected, based on Secchi disk readings.

Both total occurrence and total density increased substantially from 2000 to 2006. However, the aquatic plant community in 2006 was slightly more diverse than that in 2000, with more variety of species being present. This was especially noted in the higher presence of emergent plants in 2006. More species sensitive to disturbance were found in 2006, and the floristic quality index of the aquatic plant community was higher in 2006 than in 2000.

However, it is also true that Eurasian watermilfoil and curly-leaf pondweed were both had higher occurrences in 2006. Filamentous algae were also more common in 2006.

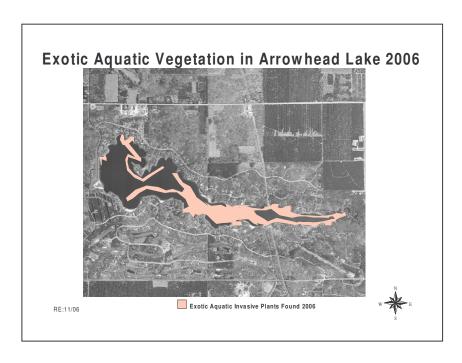
Further, although emergents were more present in 2006 than in 2000, they are still very low in total occurrence. Emergents provide important fish habitat and spawning areas, as well as food and cover for wildlife.

No floating-leaf plants were found in either 2000 or 2006. Floating-leaf vegetation provides cover and dampens waves, protecting the shore.

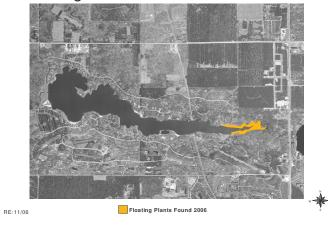
Both these plant types need to be encouraged and protected in Arrowhead Lake.

Emergent Aquatic Plants in Arrowhead Lake 2006

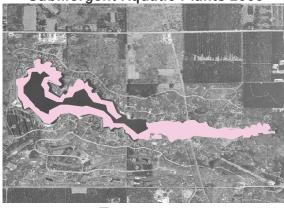








Submergent Aquatic Plants 2006





RE:11/06



Invasive Species-Animals

Arrowhead Lake is currently the only in-land lake in Adams County known to have zebra mussels. They are also found in the Wisconsin River and in both Castle Rock and Petenwell Lakes on the western edge of Adams County.

The WDNR has been monitoring Arrowhead Lake since the zebra mussels were discovered and works with the Tri-Lakes Management District to try to manage the mussels.

Because of the presence of these mussels, participation in the Clean Boats, Clean Waters program is especially urgent.

Zebra Mussels





Rusty Crayfish are also known to be in the Tri-Lakes system in all three lakes, but do not appear to have reached a level to cause any significant impact at this time.

They should be monitored, so that if they appear to be increasing in presence, action can be taken to manage them. Unchecked, rusty crayfish can seriously damage a lake's ecosystem, destroying many of the aquatic plants on which fish & their prey depend, and ultimately negatively affecting the fish population.

Fishery/Wildlife/Endangered Resources

The most recent fishery survey of Arrowhead Lake was done in October 2004. That inventory found that walleye and largemouth bass were abundant. Bluegill and white suckers were common. Both yellow perch and northern pike were scarce.

Muskrat are known to use Arrowhead Lake shores for cover, reproduction and feeding, mostly in the conservancy areas. Seen during the field survey were various types of waterfowl, and songbirds. Frogs and salamanders are known, using the lake shores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Upland wildlife feed and nest here as well.

Arrowhead watersheds contain a number of endangered natural communities, plants and animals. Natural communities in these watersheds include Alder Thicket, Northern Sedge Meadow, Northern Wet Forest, Pine Barrens and Shrub-Carr. Redshouldered hawk, also in jeopardy, is known here. Plants of concern include Crossleaf Milkwort, Grassleaf Rush and Yellow Screwstem. The area is also good habitat for Karner Blue Butterflies.

Some of the endangered resources in Arrowhead Lake watersheds (top to bottom): Red-Shouldered Hawk; Yellow Screwstem; Karner Blue Butterfly.







Recommendations

Lake Management Plan

• The Tri-Lakes Management District should continue to implement and annually review its management plan to cover at least the following aspects concerning the management of the lake: aquatic species management; control/management of invasive species; wildlife and fishery management; nutrient budgeting; shoreland protection; critical habitat protection; water quality protection.

Watershed Recommendations

- The Total Daily Maximum Load allowable needs to be determined for Arrowhead Lake. This is the total pollutant load (both point and non-point pollution) a body of water can handle without creating an impairment of that water body's designated use.
- To accumulate data necessary for that determination, it is recommended that both the surface and ground watersheds be inventoried, documenting any of the following: runoff from any livestock operations that may be entering the surface water; soil erosion sites; agricultural producers not complying with nutrient management plans and/or irrigation water management plans.
- Once the determination is made, Arrowhead Lake Association and the Tri-Lakes Management District should work with the Adams County Land & Water Conservation Department and landowners to implement plans to reduce nutrient pollution.

Water Quality Recommendations

- All lake residents should practice best management on their lake properties, including keeping septic systems maintained in proper condition and pumped every three years, eliminating the use of lawn fertilizers, cleaning up pet wastes and not composting near the water.
- Reducing the amount of impervious surface around the lake and management of stormwater runoff will also help maintain water quality.
- Residents should become involved in the Citizen Lake Water Monitoring Program. This program now includes monitoring for water quality, for aquatic invasive species, and Clean Boats, Clean Waters.
- Lake residents should protect and restore natural shoreline around Arrowhead Lake. The lower frequency and density of sensitive plant species in the disturbed shoreline areas is evidence that shore disturbance is impacting the aquatic plant community of the lake. Also, buffers of native vegetation would increase filter in of nutrients entering the lake and help shore stabilization around the lake.

• The Tri-Lakes Management District should continue to enforce its Sanitary Ordinance about regular inspection and/or pumping of septic systems in its district.

Aquatic Plant Recommendations

- All lake users should encourage the Tri-Lakes Management District to continue implementing an integrated aquatic plant management plan with the District.
- The Tri-Lakes Management District should maintain exotic species signs at the boat landings and contact DNR if the signs are missing or damaged.
- The Tri-Lakes Management District should continue monitoring and control of Eurasian Watermilfoil and Curly-Leaf Pondweed to maintain the most effective methods and modify if necessary. Residents may need to hand-pull scattered plants.
- Lake residents should get involved in the county-sponsored Citizen Aquatic Invasive Species Monitoring Program. This will allow not only noting changes in the Eurasian Watermilfoil pattern, but also those for Curly-Leaf Pondweed and other invasives. Noting the presence and density of invasives early is the best way to take control actions to keep them from becoming a bigger problem.

Animal Invasive Species Recommendations

- Lake residents should get involved in the county-sponsored Citizen Aquatic Invasive Species Monitoring Program. This will allow not only noting changes in the zebra mussel and rusty crayfish, but also note the presence of any new invasive animals known to be in Wisconsin, such as rainbow smelt and spiny water flea. Catching the presence of these invasives early is the best way to take preventive action to keep them from becoming a bigger problem.
- A detailed plan with steps for dealing with invasives should be developed and made part of the Lake Managemetn Plan.